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A Computer Vision Based Machine for Automated Packaging of Photonics Components

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At present, the high cost of optoelectronic (OE) devices is caused in part by the labor-intensive processes involved with packaging. Automating the packaging processes should result in a significant cost reduction. One of the most labor-intensive steps is aligning and attaching the fiber to the OE device, the so-called pigtailing process. Three low-cost machines were designed and built under an ARPA-funded project to perform sub-micron alignments and attachments of single-mode fibers to different OE devices. These Automated Fiber Pigtailing Machines (AFPMs) are compatible with a manufacturing environment and have a modular design for standardization of parts and machine vision for maximum flexibility. The vision system greatly reduces mechanical fixturing constraints by requiring the critical components to be positioned only within the 1 mm field of view of the camera. Object-recognition algorithms written by LLNL allow the AFPM to quickly determine the initial locations of the OE device and the fiber and to position the fiber with sufficient accuracy for fine alignment via optical throughput maximization. The performance goals of the AFPM are to operate unattended for up to 1 hour while bonding pigtails at an average rate of 3 minutes per bond (dominated by epoxy cure time). Preliminary tests yielded average rates slightly slower than the goal, however improvements are being implemented which will reduce image processing time and improve fiber manipulation accuracy. The modular nature of the AFPM means that each machine may be easily customized for a particular application. This work was a collaboration among Uniphase Telecommunications Products (formerly United Technologies

Photonics, UTP), Ortel, Newport/Klinger, the Massachusetts Institute of Technology Manufacturing Institute (MIT), and Lawrence Livermore National Laboratory (LLNL). For this project, a basic set of modules was designed to build an AFPM for UTP to pigtail $LiNbO_3$ waveguide devices and for Ortel to pigtail photodiodes. Both of these machines contain proprietary information, so the third AFPM, residing at LLNL, is used for demonstrations to US industry and for further development of AFPM capabilities.

We collaboratively designed and built a modular, manufacturing-environment-compatible machine which operates unattended and uses computer vision to aid rapid, optimized bonding of single-mode fibers to OE devices. We describe the machine's design and report preliminary test results.
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